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Recommended Citation

Wanyonyi, S., Mariara, C. M., Vinayak, S., Stones, W. (2017). Opportunities and Challenges in Realizing Universal Access to Obstetric Ultrasound in Sub-Saharan Africa. *Ultrasound International Open*, 3(2), E52-E59.

Available at: http://ecommons.aku.edu/eastafrica_fhs_mc_obstet_gynaecol/142

Opportunities and Challenges in Realizing Universal Access to Obstetric Ultrasound in Sub-Saharan Africa



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Key words

ultrasound, sub-Saharan Africa, perinatal outcomes, training

received 06.09.2016

revised 06.09.2016

accepted 31.01.2017

Bibliography

DOI <http://dx.doi.org/10.1055/s-0043-103948>

Ultrasound Int Open 2017; 3: E52–E59

© Georg Thieme Verlag KG Stuttgart · New York

ISSN 2199-7152

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ABSTRACT

The potential benefits of obstetric ultrasound have yet to be fully realized in sub-Saharan Africa (SSA), despite the region bearing the greatest burden of poor perinatal outcomes. We reviewed the literature for challenges and opportunities of universal access to obstetric ultrasound and explored what is needed to make such access an integral component of maternity care in order to address the massive burden of perinatal morbidity and mortality in SSA. Original peer-reviewed literature was searched in various electronic databases using a 'realist' approach. While the available data were inconclusive, they identify many opportunities for potential future research on the subject within the region that can help build a strong case to justify the provision of universal access to ultrasound as an integral component of comprehensive antenatal care.

Introduction

Obstetric ultrasound remains an integral component of prenatal care [1]. However, most women in sub-Saharan Africa (SSA) still go through pregnancy without the benefit of a single ultrasound examination [2, 3]. The region is responsible for the majority of the global burden of perinatal morbidity and mortality and the inability to offer imaging in pregnancy is one of the vital service gaps that may need to be closed in order to end preventable stillbirths [4]. As the clinical value of sonography is well established, efforts now need to be geared towards making obstetric ultrasound part of comprehensive antenatal care. With current technological developments in equipment quality and increasing access to smaller devices and mobile data/telemetry links that enable provision of services in remote locations together with the phenomenal reduction in costs, it should be possible for sonography to be made available in all primary health care settings [5–7]. Indeed, we have deployed midwives trained to undertake antenatal scans using portable devices in settings remote from our hospital with image telemetry transmitted using cheap mobile phone technology with encouraging results (personal communications).

However, for any investment to be justifiable, the costs and benefits have to be considered. It is necessary to critically examine whether universal access to obstetric ultrasound in SSA will improve

perinatal outcomes and also to consider the potential for harm and whether it will have a significant effect at all. The commonly appreciated benefits of access to obstetric ultrasound are well characterized [2, 8, 9] but there is a dearth of authoritative guidance on its appropriate place in maternal health services in low resource settings in general and the SSA region in particular. Where guidance is available, it is very restrictive, limiting the extent of use and the potential benefits that can be derived from sonography [10]. While medically indicated ultrasound is safe [11], potential harm cannot be overlooked when advocating for universal access. Such harm could result from unstructured dissemination of randomly applied technology [12–16].

In this paper, we review some of the challenges and opportunities regarding access to obstetric ultrasound and explore what is needed to make such access an integral component of maternity care in order to address the massive burden of perinatal morbidity and mortality in sub-Saharan Africa.

Methods

We searched original peer-reviewed literature in various electronic databases including: MEDLINE, EMBASE, PUBMED, TRIP, Google Scholar, CINAHL (Nursing and Allied health). We restricted our

search to papers written in English between the years 1990 to 2016. We searched for grey literature and also a reference list of relevant articles using the key words: Ultrasound and perinatal outcomes, obstetric ultrasound and maternal health. We further narrowed our search to specific aspects on perinatal outcomes: Birth injury, still-birth, birth asphyxia, neonatal death, maternal satisfaction, training and technological advances. We included only original research done in the SSA region. Opinions, commentary and review articles were excluded. Owing to the paucity of primary research work on the topic, we adopted a 'realist' approach in our search and literature synthesis. This was done to ensure that we extracted as many relevant studies as possible on the subject that may provide necessary information that could guide policy as opposed to a formal systematic review that would otherwise exclude most of these studies, but taking due note of the limitations of interpretation that this approach might impose [17, 18]. We referred to studies undertaken in well-resourced settings for comparative purposes.

Results and Interpretation

A total of 17 studies met the search criteria and were included in the review. A majority of the studies [14] were observational/descriptive studies with only 2 randomized control trials (RCTS) and 1 RCT protocol (► **Table 1**). These were broadly categorized into the following themes: ultrasound and perinatal outcomes, training, portable ultrasound and telemedicine and knowledge, perception and practice.

Ultrasound and perinatal outcomes in SSA

The role of obstetric ultrasound in improving perinatal outcomes was comprehensively addressed in the Routine Antenatal Diagnostic Imaging with Ultrasound (RADIUS) trial, which concluded that screening ultrasonography did not improve perinatal outcomes [19]. Interestingly, these findings have been supported by subsequent studies. In fact not only do they support the findings, but also show that ultrasonography could lead to an increase in obstetric interventions such as instrumental deliveries and cesarean section [20–22].

These findings of 'no evidence of benefit' are in contrast with the benefits of ultrasound to individual patients for determining gestational age, enabling early diagnosis of pregnancy problems, and the psychological benefits that have been separately described [1, 8, 9]. Clinicians in the SSA region are all too aware of how the lack of obstetric ultrasound results in 'unpleasant surprises' during labor or delivery. Some frequent encounters from our practice in SSA include unexpected twin gestation, undiagnosed placenta previa or morbidly adherent placenta resulting in unplanned hysterectomy and unanticipated massive obstetric hemorrhage. Other scenarios include undiagnosed breech presentation leading to unplanned difficult deliveries. In the event of additional undiagnosed congenital anomalies such as hydrocephalus, one has to resort to destructive procedures with resultant maternal trauma and morbidity and these are especially traumatic when undiagnosed until delivery, for example with a 'stuck head'. The frequency of these occurrences is unknown, mainly owing to a lack of reliable reporting systems. Our assumption is that these experiences are more common in regions in SSA with limited or no access to obstetric ul-

trasound but the literature does not capture such episodes in a manner that is amenable to analysis. This contrast between formal findings of 'no evidence of benefit' and the type of every day clinical experiences described above lead us to question the clinical meaning of the findings from the previously quoted studies. If indeed ultrasound does not confer perinatal benefit, then one may want to assume that many countries have invested heavily in a technology that is non-essential. This is unlikely to be the case.

The potential benefits of wider access to obstetric ultrasound extend beyond considerations of perinatal mortality. In settings where the majority of pregnancies are 'low risk' and other service elements are fully deployed and effective, any additional interventions may not have a measurable impact on a major outcome such as mortality. Access to obstetric ultrasound could, however, have a wider range of effects. An important benefit has been demonstrated in some settings in SSA in the form of an increase in the number of women seeking antenatal care as a result of being offered ultrasound examinations [21–23] and this can be anticipated to translate to better maternal and perinatal outcomes. Studies have also proved the usefulness of ultrasound in targeted examinations [24]. Intrapartum-related adverse outcomes could be reduced by the adoption of simplified umbilical artery (UA) Doppler studies in late pregnancy in regions with high perinatal death rates [25, 26]. Among the many ultrasound interventions, Doppler velocimetry of the UA and ductus venosus (DV) in fetal growth restriction with timely and appropriate interventions has been shown to significantly reduce stillbirth rates [27, 28].

Avoiding adverse maternal outcomes

One major role of ultrasound remains the accurate confirmation of gestational age. Accurate determination of gestational age has remained elusive in the SSA region. This has not only affected decision-making in pregnancy but also the interpretation of findings in perinatal research in the region. Accurate estimation of gestational age reduces the number of unnecessary interventions such as labor induction, iatrogenic preterm birth and primary cesarean section [29, 30]. A major hindrance to accurate estimation of gestational age is late antenatal booking, for example with most women attending for the first time in the mid-second trimester. A range of community mobilization and health service approaches is needed to encourage women to attend earlier in pregnancy. However, access to ultrasonography for fetal biometry with the use of the femur length (FL)/head circumference (HC) ratio in these settings has the potential for application in the 2nd and early 3rd trimester with almost equal accuracy [31].

Ultrasound could also play a major role in reducing adverse maternal outcomes, mainly "near miss" morbidity and mortality [32]. Emphasis has mainly been on the neonatal and fetal outcomes, yet maternal conditions directly contribute to the perinatal outcomes. For example, a study in Rwanda reported that up to 37 % of patients could have a wrong diagnosis, which could be corrected by incorporating ultrasound in their care [33]. Ultrasound may also result in recognition of conditions that could otherwise have been missed and resulted in adverse outcomes such as a placenta previa, invasive placenta, undiagnosed multiple pregnancies and malpresentations, leading to life-saving interventions in up to 48 % of women [32].

► **Table 1** Summary of studies.

	Study design	Objective	Study size	Main findings	Country
Gonzaga MA et al. 2009 [35]	Cross-sectional qualitative	To assess knowledge, attitude and practice of pregnant women towards prenatal sonography	30 pregnant women who had undergone ultrasound	Obstetric sonography is highly appreciated as being vital for antenatal care. However, there is need for mothers and health care providers to be well informed about the safety and specific purposes of obstetric sonography and what it can and cannot achieve.	Uganda
Goldenberg RL et al. 2007 [28]	Secondary analysis of demographic data	To explore the relationship between intrapartum and antepartum stillbirths and the various measures of obstetric care	N/A	The intrapartum stillbirth rate is more closely related to various measures of obstetric care, and is a reasonably good reflection of the quality of obstetric care in a country. In developing countries, the intrapartum stillbirth rate correlates strongly with the percentage of births by cesarean section.	Multi-country
Meloni MF et al. 2007 [44]	Observational before and after study	To assess the feasibility of a sonographic training program and the effect of the program on public health care	10 trainees	7 of 10 trainees were admitted to the second year of the sonographic training program. The mean monthly hospital earnings during the 3-course period were 673 200 Tanzanian shillings.	Tanzania
Greenwold N et al. 2014 [45]	Prospective cohort study	To evaluate the feasibility and sustainability of basic obstetric ultrasound training in rural Africa	1744 pregnant women and medical personnel	The detection rates for the different ultrasound variables were similar in the 2 subgroups – except for the detection of fetal anomalies, which was significantly ($P < 0.001$) higher in the subgroup scanned by trainees under the supervision of the trainer.	Mozambique
Yeboah MY et al. 2010 [32]	Cross-sectional study	To evaluate the appropriateness of requests for obstetric/gynecologic ultrasound	210 women referred for ultrasound	The standardization of obstetric/gynecologic ultrasound request forms may improve the clinical information provided. Clinical evaluation and provision of sufficient clinical details should be regarded as the gold standard of practice.	Ghana
McClure EM et al. 2014 [8]	Randomized control trial (RCT) protocol	To determine whether ultrasound use will improve care and ultimately pregnancy outcomes in low recourse settings	58 study clusters each with a health center and about 500 births per year	N/A	Kenya
Geerts L et al. 1996 [21]	RCT	To assess the overall adverse perinatal outcome and use of antenatal and neonatal services	988 pregnant women without risk factors for congenital anomalies referred for ultrasound between 18–24 weeks of gestation	More suspected postdate pregnancies occurred in control patients, as well as more amniocenteses for confirmation of lung maturity. More babies of low birth weight were born in the study group. The incidence of overall or major adverse perinatal outcome was comparable. Routine ultrasonography was accompanied by a considerable increase in costs.	South Africa

► **Table 1** Continued.

	Study design	Objective	Study size	Main findings	Country
van Dyke B et al. 2007 [22]	Open cluster RCT	Investigate the effect of routine second trimester ultrasound on obstetric management and pregnancy outcomes	955 women with low-risk pregnancies at 18–23 weeks of gestation	There were no significant differences between the groups in terms of prenatal hospitalization, delivery, miscarriage, perinatal mortality and low birth weight rates. High priority can therefore not be given to provision of routine pregnancy ultrasound screening in poorly resourced settings.	South Africa
Tautz S et al. 2000 [34]	Qualitative study	To assess women's experience of ultrasound scanning and how their experience concurs with health professionals' views	41 pregnant women and observation of 18 doctor-client interactions	Most women viewed ultrasound as being beneficial. Some expressed considerable fear. Women overestimated the diagnostic power of ultrasound. Technology and its often expatriate providers tend to be a source of mystification and at the same time non-technological procedures provided by local staff in the context of normal history taking and antenatal care are undervalued. Health staff admitted, however, that since the availability of ultrasound they have been tempted to take histories and physical examinations less thoroughly than before.	Botswana
Oluoch AO et al. 2015 [36]	Descriptive study	To describe the uptake and provision of antenatal care and explore how pregnant women and health care providers perceived the provision of ultrasound scanning	10 nurses, 59 pregnant women and observation of 357 ANC consultations	Ultrasound scanning was perceived to enhance antenatal care by confirming pregnancy status and enabling more accurate estimation of gestational age and the health status of the fetus.	Kenya
Menshah et al. 2014 [37]	Cross-sectional study	To determine knowledge of antenatal ultrasound, its use in pregnancy, adequacy of information provided by health workers and assessment of scanning experience	337 post-delivery women	Women perceived antenatal ultrasound as a useful tool. There is a lack of information flow from health care providers to clients concerning the indications for ultrasound, the process involved and the results of the procedure.	Ghana
Shah S et al. 2015 [40]	Online survey	To assess perceived barriers to ultrasound use in resource-limited settings	138 health care providers	Lack of training is the primary barrier to regular use of ultrasound.	Multi-country
Bagayoko CO et al. 2014 [6]	Cross-sectional study	To evaluate the impact of telehealth on the diagnosis and management in obstetrics and cardiology, health care costs from patients' perspective and attendance at health centers in remote areas.	215 cases	Telehealth removed health care management systems in remote areas.	Mali

► **Table 1** Continued.

	Study design	Objective	Study size	Main findings	Country
Swanson JO et al. 2014 [43]	Prospective observational study	To evaluate the diagnostic impact of limited obstetric ultrasound in identifying high-risk pregnancies when used as a screening tool	939 patients	Limited focused obstetric US screening by midwives improved the diagnosis of early pregnancy complications as well as later gestation twins and malpresentation.	Uganda
Wylie BJ et al. 2013 [42]	Before and after study	To pilot the feasibility and utility of adding ultrasound to an observational study for the purpose of gestational age assessment	178 pregnant women	Ultrasound should be used to confirm gestational age and avoid the misclassification of infants as premature or growth restricted.	Malawi
Enakpene CA et al. 2009 [38]	Cross-sectional study	To determine the reasons why pregnant women desire a prenatal ultrasound	222 pregnant women	Preferences were influenced by biosocial variables.	Nigeria
Shah SP et al. 2009 [33]	Before and after study	To investigate the impact of a diagnostic ultrasound program in 2 rural district hospitals	Health care providers in 2 rural health facilities	Ultrasound is a useful modality that particularly benefits women's health and obstetrical care in the developing world.	Rwanda

Knowledge, use and misuse of ultrasound

Technological advances are usually received with lots of excitement among consumers. However, this could be detrimental to the achievement of the intended health benefits. Before any new technology is adopted, it is important that knowledge exists not only among those who will operate it but also the end users. In the case of obstetric ultrasound, it is important that health workers who intend to use it are trained on both the technical aspects and safety measures to achieve the desired results and minimize harm.

Knowledge among women in SSA on the usefulness of ultrasound is mixed. Even though some women may view ultrasound as beneficial others still express fear. Contextualizing the indication for use of obstetric ultrasound taking into consideration societal and cultural influences and appropriate communication could result in proper uptake and discourage inappropriate expectations and demand [34]. Health workers could play a key role in encouraging uptake by correct communication of the need for ultrasound and having the results communicated back not only to the referring practitioners but also directly to women at the point of care [35]. Used this way ultrasound may enhance antenatal care uptake as women get excited about the prospects of pregnancy confirmation, determination of the health status of their baby and confirmation of gestational age [36–38].

It is important to note that inappropriate indications for obstetric ultrasound and the amount of information that can be derived from the scan could result in inaccurate communication of results to patients. Standardization of obstetric ultrasound request cards to improve the detail of provided clinical information resulted in improved reporting [39]. There are also misconceptions of potential harm to the fetus and/or the mother and these could conse-

quently affect uptake [35]. Lack of national policy and practice guidelines on appropriate use of ultrasonography in pregnancy in most low and middle-income countries (LMIC) has meant that service content and quality are not consistent.

Overuse of ultrasound especially for commercial gains is a real threat that cannot be ignored [12]. Many unnecessary scans could be performed when not indicated, mainly for financial gain. Moreover, the misuse of ultrasound for gender selection as evident in South and East Asia could result in anxiety regarding its adoption elsewhere [15, 16].

Training in ultrasound

Increase in knowledge and competencies in obstetric sonography can be achieved through appropriate training programs. One major challenge in LMICs is the lack of adequate human resources for health. Besides a lack of machines, health workers have identified training as the major barrier to ultrasound uptake in SSA [40]. One approach that has been adopted in some areas to address the shortage is 'task shifting' or 'task sharing'. Emerging evidence on the use of this approach has been reported. In Thailand, locally trained health workers in a refugee camp were able to obtain fetal biometry measurements that were associated with low standard deviation values and within the normal limits of published Asian and European populations [41]. Similar programs targeting mid-level health workers and midwives have proved successful. In one study, mid-level health care workers were able to significantly influence change in clinical care after being trained in sonography by identifying up to 87 % of fetuses mislabeled as preterm and up to 27 % of babies misclassified as small for gestational age [42]. Other strategies have included limited focused ultrasound training to enable

its use as a triage tool in identifying high-risk pregnancies in need of specialized care. This approach led to improvement in recognition of twin gestation and accurate confirmation of gestational age [43]. In Rwanda, an ultrasound-training program showed a significant impact on patient clinical management especially with regards to the need for surgical interventions with a change in management plans of up to 43 % [33].

Sustaining obstetric ultrasound competencies among health care providers providing maternity care

Most obstetric ultrasound training programs have been reported to be highly sustainable with adequate maintenance of acquired skills, long after the instructors leave [12, 33, 44]. However, there are still challenges with the content of training and how to sustain the acquired skills without tempting health workers to work beyond their levels of competence. Training programs should be aimed at addressing a specific service need and not to create experts in the field. One way to achieve this is to approach the training in a hierarchical manner. The initial step could involve identifying key persons in either obstetrics or radiology at regional/tertiary institutions to drive the process and provide leadership. Mechanisms of integrating obstetric and radiological services need to be harmonized. This senior leadership could then oversee the training of other cadres of health staff in obstetric scanning. The critical target group of providers should be midwives or other primary care-level personnel identified based on tailored task-shifted models appropriate to the population needs that avoid depleting other parts of the service. Such an approach may be sustainable and fruitful if done within a framework of supportive supervision with ready access to a referral chain.

The referral chain could consist of health workers with structured and certified levels of competencies. These can be stratified into basic, intermediate and advanced scanning competencies. The components of basic ultrasound would include: crown-rump length (CRL)/dating scans, confirmation of viability, identification of multiples, very gross anomalies, placenta previa and placental localization before repeat cesarean section. Intermediate competencies could include: fetal biometry, growth, amniotic fluid volume estimation and localization of fibroids or other adnexal masses. Advanced level competencies could consist of detailed anomaly assessment including cardiac assessment and multi-modal fetal assessment such as Doppler studies.

Good quality imaging and reporting can be obtained and maintained through team work by feeding specialist expertise into the broad health system while extending sub-specialist competencies and linking with other aspects of the 2 disciplines, including other imaging modalities in the case of radiology. In view of the very limited number of specialists and subspecialists in the field, the use of remote web-based training and updating of competencies could be adopted. This has been demonstrated to have similar levels of feasibility, efficiency and sustainability with the potential for improved outcomes relative to traditional training approaches [45]. There are also opportunities to exploit the use of telemetry to enhance and improve the interpretation of scans especially after the trainers are no longer present. Studies in Mali have demonstrated that, besides this technology improving diagnostic accuracy, it re-

sults in a significant cost reduction and reduced referral to tertiary centers [6, 7]. This approach is also associated with high rates of acceptability among health workers in Africa [39].

The potential for abuse of the knowledge gained for either monetary or personal gain via diversion of patients is, however, a consideration and there is a need for training and professional development to emphasize ethical principles of clinical practice and accountability to reduce misuse, overuse or misdiagnosis with ultrasound technology [45].

The emerging role of portable ultrasound

As with most technological advances, there is constant improvement and innovation, with smaller devices being developed that could still achieve the same purpose as older bulkier machines. These smaller devices have lower energy requirements and are easier to install and cheaper to maintain. This is a promising opportunity for increasing access to ultrasonography, especially in low resource settings where there are challenges with energy supply, security and space [46]. This could mitigate the high costs of installation and maintenance of equipment, which have been major barriers to ultrasound access in SSA [40]. Portable ultrasound units could also be useful at the point of care where there is a need to make an urgent decision in women who have not had a prior perinatal ultrasound. This could be used in the clinical situations described above that result in potentially lethal 'unpleasant surprises' [42, 43, 47]. Furthermore, inappropriate decisions made in an emergency setting can be made owing to a lack of access to ultrasound. This could be avoided with quick point-of-service ultrasounds. Examples include cases of women with fetal demise being rushed for cesarean delivery with the maternal pulsations being confused for fetal bradycardia.

Caution is still needed with the currently available portable technology as these devices may not yet have the capacity for more specialized examination and the image resolution may not be adequate to allow for the detection of subtle features [12]. There is no doubt that with time they will be refined to achieve the same results as current conventional machines. The suppliers or providers of these instruments should therefore consider improving the capabilities of these machines while reducing costs. They should also participate or even promote standardization in training to differentiate experts from routine users [3]. This will enable the application of newer technology with the potential to improve accessibility and quality of services. Overall, portable ultrasound holds great promise for the developing world [47, 48].

Opportunities

Obstetric ultrasound continues to be an integral part of quality obstetric care worldwide. This benefit could also be realized in low resource settings. The opportunity to test the benefit of obstetric ultrasound exists in these low resource settings. In these settings a large proportion of women do not yet have access to obstetric ultrasound. Therefore, meaningful randomized control trials can be conducted. Such a trial would be considered appropriate from an ethics standpoint firstly because these services do not currently exist; secondly since the service has been shown not to improve perinatal outcomes elsewhere so no harm will be done if some women are denied this opportunity; lastly the women who do not undergo the intervention will not have been denied any service

since they will continue to receive the standard care they would have received anyway.

It is also becoming more difficult to justify restrictive approaches such as the ones advocated by the WHO antenatal models for LMIC in the light of experience from maternal health systems that have achieved very low rates of maternal and perinatal mortality. For instance, the WHO “focused antenatal care” model recommends the use of ultrasound only in special conditions such as twin or high order pregnancies and emphasizes that only examinations ‘that serve an immediate purpose and that have been proven to be beneficial should be performed’ [10]. This position is incomplete or even potentially misleading, since it is inevitably difficult to identify those women who may benefit from ultrasound without performing ultrasound in the first place. For example, it is not possible to know whether a woman has a multiple pregnancy and could potentially benefit from an ultrasound examination without an ultrasound being performed in the first place to determine the number of gestational sacs. Universal access to obstetric ultrasound should therefore be the default goal for service provision.

There are also opportunities to achieve gradual change regarding access to obstetric ultrasound emerging in the sub-Saharan African region (SSA), with the increasing specialist and generalist health workforce, a booming market for health services in some countries in the region, active healthcare professional bodies and increasing investment by national governments and transnational partners directed towards the achievement of the ambitious health improvement targets set out in the Sustainable Development Goals.

Conclusion

The potential benefits of obstetric ultrasound are yet to be fully realized in SSA due to challenges ranging from individual patients to institutional and national policies. While there may be conflicting evidence on the impact of universal access on perinatal outcomes, the region presents many research opportunities that could provide answers to these questions.

Potential Research Areas

There are several questions that have not yet been fully answered. These include:

1. The role of obstetric ultrasound in reducing composite perinatal outcomes (for example, including preterm birth, stillbirth and intrauterine growth restriction) in regions that do not yet have this technology available.
2. The role of ultrasound in avoiding adverse maternal outcomes and morbidities (near-miss events) and a means to assess the clinically important aspect of ‘avoiding unpleasant surprises’.
3. The impact of the deployment of early pregnancy sonography on the uptake of antenatal care and the effects on women’s pregnancy and birth preparedness.
4. How to scale up training and sustain competencies in obstetric ultrasound among health workers in low resource settings.
5. Improving communication skills among sonographers with emphasis on how to communicate ultrasound findings during and after scanning to women and to effectively use referral systems.

6. The potential role of portable ultrasound as a point of care tool in intrapartum decision-making.
7. The role of telemetry in improving both training and the interpretation of obstetric ultrasound.

Conflict of interest

The authors declare that they have no conflict of interest.

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